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THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

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Articles PAGE

A Political Star Chart of the Twelfth Century (with Plates VI and VII) ..... *W. Carl Rufus* 33
July Weather Along the Path of Totality in Canada—Solar Eclipse July 9, 1945 ..... *A. J. Connor* 42
Russian Solar Eclipse Plans for July, 1945 ..... *G. Fesenkov* 51
Important Considerations in Making Reflecting Telescopes ..... *Frank Vaughn* 53
Periodicity in Population Fluctuations ..... *D. J. McDonald* 59
The Wray Telescope of the Victoria Centre of the R.A.S.C. ..... *K. O. Wright* 65

Notes and Queries
A New Set of Sky Maps (*R.J.V.*); Astronomy Always Useful (*C.A.C.*) 68

Meetings of the Society
At Victoria 70

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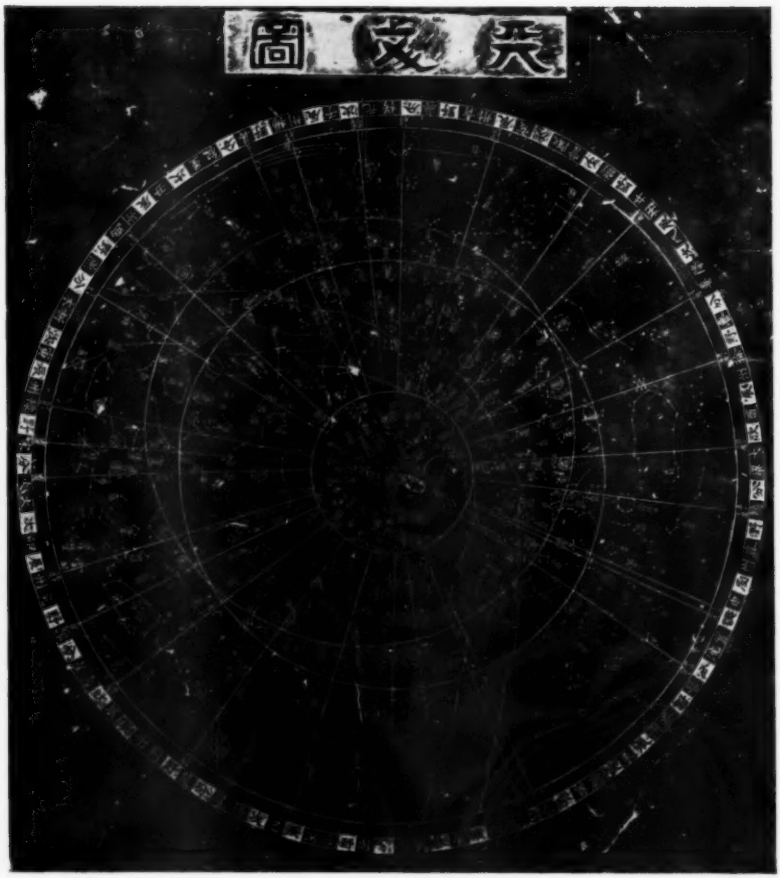
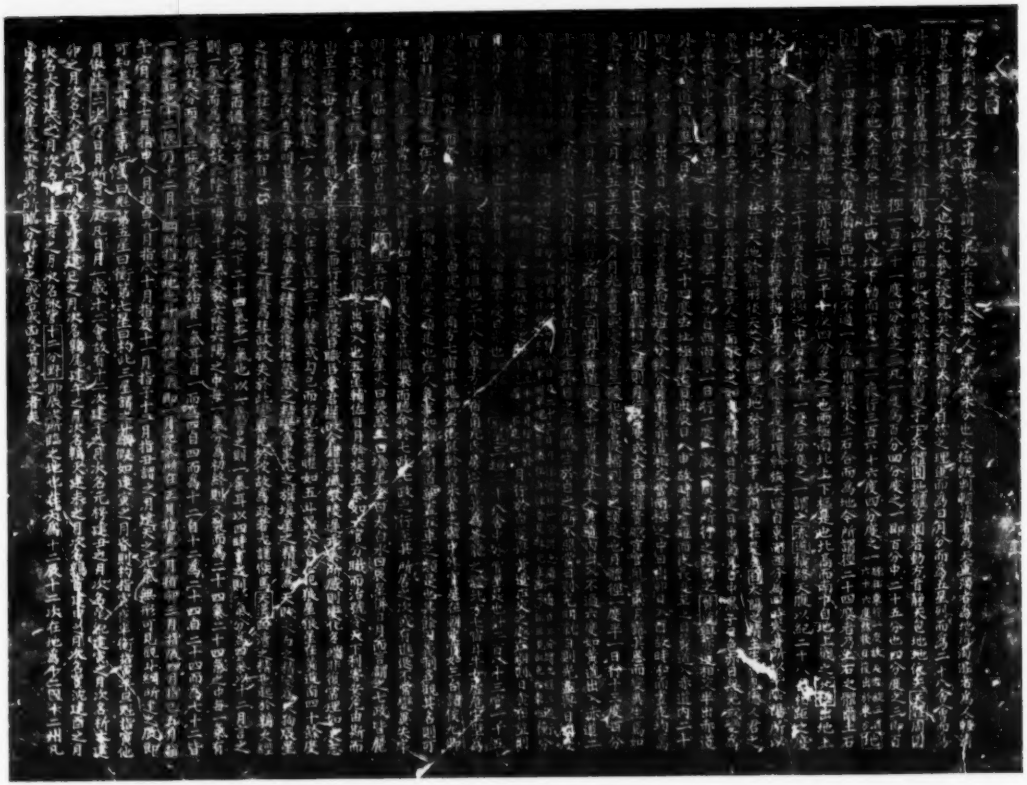
PLATE VI



A Political Star Chart

The original is an engraved stone in a Confucian temple near Soochow, China. *The Star Map* constitutes the upper part of the chart.



A Political Star Chart

The Instructions for a Future Emperor constitute the lower part of the Chart.

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A POLITICAL STAR CHART OF THE TWELFTH CENTURY

(With Plates VI and VII)

By W. CARL RUFUS

AN article on "Ancient Chinese Astronomy" by Herbert Chatley[1] of London contains a star map characterized as the best Chinese map known to him. He inserted a reproduction of the map by Edouard Chavannes[2] of Paris; the original of which is a stone engraving in a Confucian temple near Soochow containing the map and instructions for a future emperor compiled in 1193. Chavannes published a French translation of the test but omitted the asterisms of the map; Chatley cut off the interesting text below the map which contains the instructions. I have a copy of the original chart, which was recently translated by Mr. Hsing-Chih Tien and myself, including both the asterisms and the text.[3]

Astronomy under royal patronage began at a very early period in China. After the legendary Heaven Emperors and Earth Emperors, came the first Man Emperor, Fu-hsi, twenty-ninth century B.C., the traditional founder of the civilization of ancient China. According to the Classics, Emperor Yao, twenty-fourth century B.C., commanded his astronomers: "Now listen you two, Hsi and Ho! The round year consists of 366 days. By intercalary months make the lunar year agree. Indicate precisely the time for all works, so they may prove fruitful." His successor, Emperor

[1]Ancient Chinese Astronomy, Royal Astronomical Society, Occasional Notes No. 5, 65-74, 1939.

[2]L'Instruction d'un Futur Empereur de Chine l'An 1193, Carte Astronomique, Academie des Inscriptions et Belles-Lettres, Memoires concernant L'Asie Orientale *1*, 43-57, 1913.

[3]The Soochow Astronomical Chart, accepted for publication by the University Press.

The Instructions for a Future Emperor Constitute the Text Part of the

Shun, "examined the gem-adorned turning sphere and transverse tube, that he might regulate the seven directors." These emperors, lauded for their astronomical achievements, were called Sons of Heaven and their country, the Celestial Empire.

The royal astronomers were ordered: "To calculate and delineate the movements and appearances of the sun, the moon, the stars, and the zodiacal spaces and so to deliver respectfully the seasons to the people." When the days were of medium length it was midspring and midautumn; at the limits of the shadow it was midsummer and midwinter. Thus the astronomers observed the heavenly bodies for practical purposes in agriculture and other activities in daily life, also for guidance in state affairs. In this way the emperors "faithfully worshipped heaven and diligently served the people." Under Emperor Hsia, 2205 B.C., the will of heaven became the law of the earth. Hsi and Ho (royal astronomers) negligent of their duties at the time of an eclipse were punished by death.

Practical astronomy thus became highly developed and excellent instruments were made. Many phenomena were recorded beginning at an early period, including solar and lunar eclipses, which were predicted, also comets, meteoric showers, sunspots, planetary conjunctions, star occultations, and so-called guest stars, which probably included novae and variables. Dynastic historiographers also recorded many meteorological and other natural phenomena, such as severe hail and frost, disastrous floods, tornadoes and earthquakes.

During the Chou dynasty, 1122 B.C. to 225 B.C., sundials and water clocks were used. The star configurations were standardized by measuring their relative positions. The obliquity of the ecliptic was determined and it is claimed that its change was noted. Precession of the equinoxes was known during the Early Han period, 206 B.C. to 25 A.D., and variation of the moon's motion was studied under the Later Hans, 25 A.D. to 220. The "solar precession" was taught by Yu Hee, 205 A.D., i.e. the sun's circuit of the heavens was $365^{\circ}26$ and the sun's circuit of the year was $365^{\circ}24$. (The circle was divided into $365\frac{1}{4}$ degrees, so one degree was equivalent to one day.) This distinguished the sidereal year from the tropical year. In the fifth century the stationary points and retrograde motion of the planets were calculated, and in the sixth the equation of the sun's centre was fixed. The Tang dynasty, 618-907, witnessed great

national expansion and cultural advancement in literature and art. Paper making and block printing were developed and gunpowder (not for guns) was invented. Astronomy suffered a temporary eclipse.

The period of the Five Dynasties with ten militant kingdoms was followed in 960 A.D. by partial unification under the Sung Dynasty in the North. Struggles continued with the Kitan Tartars, the Western Liao and the Golden Tartars, who set up the Chin Dynasty in 1115. After the fall of the North Sung capital, Pien Liang, in 1126, the North was abandoned to the Manchus and the South Sung period began. The new royal astronomical instruments were moved to Peking and stored until 1154 when the first one was mounted on the city wall. In 1214 the new emperor gave up Peking and moved his capital to K'ai-Feng Fu, Honan. New emphasis was placed on the Classics as a basis for propagating Chinese culture and developing a racial consciousness to promote unity. The state socialism of Wang An-shih had been tried and rejected. The old, which was tried and true, was selected as a basis for permanence, hence the instructions to a future emperor prepared in 1193 and engraved in stone in 1247. Twenty years later Peking was restored as the capital.

The star map, which forms the upper part of the chart, represents the stars on the plane of the equator with the north pole at the centre. The smallest circle contains the circumpolar constellations, those always above the horizon. The two intermediate intersecting circles are the equator and the ecliptic. The outside circumference cuts off the invisible southern circumpolars. These circles fix the latitude at 35 degrees, which agrees with K'ai-Feng Fu rather than Peking. The 28 zodiacal constellations or lunar mansions of the ancients are emphasized by inscribing their names within small circles. Radial lines from the central circumference to the outer one form 28 unequal divisions, which combined by sevens form the four quadrants, the Blue Dragon of the East at the left, the Black Tortoise of the North at the top, the White Tiger of the West at the right and the Red Bird of the South at the bottom. The broad imagination used to note resemblance of form to the object named far surpasses that required for the occidental constellations, as the sweep of a full quadrant of the zodiac is included for each

animal. The four quadrants and the central portion form the five grand divisions of the map. Three large areas are called walls or compounds—the Purple or Imperial Court, the Celestial Market Place, and the Secret Court or Privy Council.

Comparing the Soochow Chart with other Oriental star maps it appears that many "idealizations" have been introduced for the emperor. Perhaps the use of this term is faint praise; because we

FIG. 1. THE BLUE DRAGON OF THE EAST

A painting on the east wall of a Han tomb, west of Pyeng Yang, Korea. The most fabulous, most storied, most revered mythological animal of the orient. It gives its name to the Dragon throne. The middle star of the heart of the Dragon, Big Blaze, marvelous to relate, is Antares, a red giant star, one of the largest measured by twentieth-century methods.

mean the change of the form of an asterism from the true observational pattern in the sky to make it conform with the conventional name of the basic idea involved.

Chinese star names differ widely from the occidental. Instead of mythological heroes and superhuman beings, we find real terrestrial men and women, e.g. within the Imperial Court reside the emperor, the royal family, the queen and court ladies, the crown

prince, and even the son by a concubine. The walls of the Celestial Market Place are modernized and idealized. Merchants from new kingdoms are present. The market circle or bargaining centre is better organized. Standardized weights and measures are provided to insure fair dealing. The Compound of the Secret Court has been completely changed, not greatly in form, but the gates are replaced by generals and officials. Here the extremely practical and mundane aspect may be well illustrated by modestly introducing an

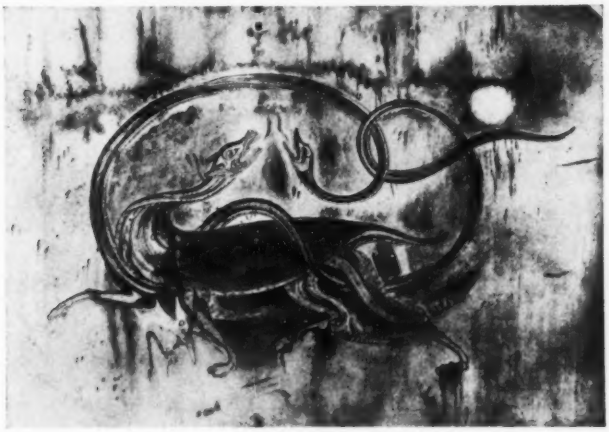


FIG. 2. THE BLACK TORTOISE OF THE NORTH

A painting on the north wall of a Han tomb, west of Pyeng Yang, Korea. Singular, not plural; although there are two animals, the tortoise and the serpent. Not in mortal combat, as frequently interpreted. Together they represent the Yin-Yang, whose comingling is essential in cosmic creation.

asterism, neatly concealed from public view by a high Celestial Fence or Screen—the Heavenly Well or Pit of Ease, a euphemism, parallel with comfort station.

The practical aspect of the idealized star map is applied and enhanced in the text, a few excerpts of which will suffice.

"Before the Great Absolute had unfolded itself, the three primal essences, Heaven, Earth, and Man were involved within. This was

termed original chaos, because the intermingled essences had not yet separated. When the Great Absolute unfolded, the light and pure formed Heaven, the heavy and impure formed Earth, and the mingled pure and impure formed Man. The light and pure constitute spirit, the heavy and impure constitute body, and the union of spirit and body constitutes man. Hence all manifestations of spirit emanate from Heaven, for a natural and logical reason, being in-

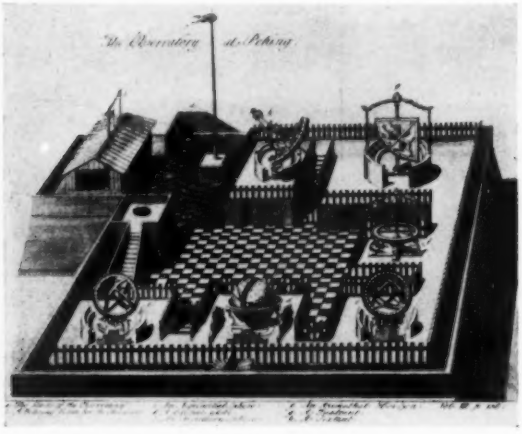


FIG. 3. THE OBSERVATORY AT PEKING

For a description of these instruments see "Sky," Vol. III, No. 6, p. 6, 1939. Father Matteo Ricci, who saw the instruments, said that he had seen nothing like them in Europe, although they had been exposed to the weather for two hundred years.

The picture is reproduced from *The General History of China*, from the French by (J.B.) P. Du Halde, third edition, London, 1741, Vol. III, opp. p. 108.

herent in the Great Absolute. This evolves into the Sun and the Moon, divides into the five planets, arranges in order as the 28 mansions and reunites to form the directors and the circumpolar stars. All of these being involved in the immutable directing reason are also in harmony with the rational principle in Man, so they may be interpreted by reason."

The cosmogony of this initial passage accounting for the unity

of the trinity, Heaven, Earth, and Man, is fundamental in the philosophical and political system of the chart. From the standpoint of Man, formed by the union of spirit and body, Heaven and Earth are objective and constitute the rational, interpretable universe, which is likewise composed of mind and matter. The system provides a basis for the mutual response between Heaven and Earth and links events celestial with events terrestrial. Natural celestial phenomena were not ordinary portents of terrestrial affairs, they were their counterparts. Thus star observations indicated what was happening on the earth. The motions of the Sun, Moon, and planets and the occurrence of eclipses, conjunctions, and other phenomena, were related to the affairs of state and to the welfare of distant parts of the Empire. This practice has been called "a rather elaborate system of political astrology." The adjectives are apt and pertinent; but the substantive, astrology, cannot be accepted without a word of explanation. The prediction of individual, social, and political events is minimized. Prediction is not as significant as the function of correlating celestial and terrestrial events, for the benefit of the emperor, including advice, admonition, and warning to be given to the people.

The astronomical doctrines of the period are well summarized. Heaven is round and is in constant changeless motion; Earth is square and motionless. 'Heaven encompasses Earth and Earth responds to Heaven." The equator constitutes the Heart of Heaven where the central spirit resides. It makes Heaven turn from east to west. It produces day and night and the four seasons and causes Yin and Yang to cooperate. (These are the negative and positive natural principles, also termed feminine and masculine.) The sun is the essence of the Great Yang, ruling with beneficence, and symbolizes the Emperor. When the sovereign possesses virtue, the sun shows no imperfections; when he loses virtue there are eclipses, dark spots and other blemishes. The moon is the essence of the Great Yin, ruling with stern authority and symbolizes the prime minister. When that official rules virtuously, the moon moves regularly; otherwise the moon may be eclipsed or occult the planets.

Some of the fixed stars and asterisms symbolize various officials and magistrates; others symbolize animals, e.g. the cock, the dog, the wolf, the tortoise and the turtle; still others symbolize human

works, e.g. palaces, avenues, processional canopies and imperial carriages. Many asterisms, however, have names designating their own significance and may be identified on the map by their form. The stars move regularly with Heaven, when the officials rule wisely and human affairs run smoothly. The planets, like the ministries, are related to prosperity and peace, adversity and peril.

The Seven Stars of the Dipper are the regulators, which perform an important function during the year by pointing toward the Twelve Branches and the Twelve Positions. During each month the primordial vitalizing spirit resides in the Branch indicated. The Twelve Kingdoms and the Twelve Regions are parts of the Celestial Empire corresponding to the Branches and Positions. When an eclipse or any unusual phenomenon occurs, the fortune or misfortune of the corresponding part of the Empire may be predicted. The correlation is effected by knowing the positions in the sky and the assigned compass directions to the corresponding geographical divisions. Ten of the twelve regions of the chart agree with designations on a political map attributed to the period of the Five Emperors, about 2500 B.C. Two other regions are included, which were outside the national boundaries, so the number twelve corresponds. Good agreement is also found with a map of the Chou period about 500 B.C. and with one of the Hans, first century A.D.

Although practical astronomy was well developed especially for calendar making and the Chinese had the best instruments in the world at that time, we must conclude that the astronomy for an emperor of the twelfth century with its inherent idealization was rather poor astronomy, and we cannot recommend it merely from the standpoint of astrology, although it compares favorably with that practiced by Kepler and others at the courts of Europe five centuries later.

The engraved stone, however, deserves to be classed as one of the outstanding contributions of all time, because it epitomizes the political philosophy of the most enduring human government the world has ever known. In modern flippant phrase, Confucius say, "Emperor look up, heaven; Emperor look down, earth." The celestial emperor looked up to heaven for instruction, for direction, for eternal verities, in accordance with the constitution of the universe. He looked down to earth to put those eternal principles into practice

as he ruled his people beneficently according to the decree of heaven.

That constitutes the realism of the chart. It is not found in the science of astronomy, nor in the realm of astrology. It is founded in the ideology, or perhaps we may say in the enduring political science of the Celestial Empire.

The charge of idealization of the asterisms may not be welcomed by sinologues. European students of Chinese Astronomy include many prominent names,—Laplace, Gaubil, Biot, Schlegel, John Williams, Chavannes, and Chatley, who have given the subject serious consideration. Effort has been made to identify not merely each asterism but also every star. Due to idealization this is an impossibility and has led to much confusion and many contradictions. Of course there is unanimous agreement in the case of a large number of conspicuous constellations and bright stars. The remainder constitute a Chinese puzzle; one proposed solution of which is idealization for a practical political purpose.

The Observatory of the University of Michigan,
Ann Arbor, Michigan.

JULY WEATHER ALONG THE PATH OF TOTALITY IN CANADA—SOLAR ECLIPSE JULY 9, 1945

By A. J. Connor

ASTRONOMERS planning to observe the total solar eclipse on the 9th of July next wish to know something about the weather possibilities along the path of totality. The path enters Saskatchewan from Montana on the western slopes of Wood mountain near longitude 105°. It passes northeastward over Wolseley, Sask., a little east of the city of Regina, and thence near Yorkton, Sask. Near Kamsack it will cross Duck mountain in Manitoba. Duck mountain is an extensive area generally about 2,000 to 2,500 ft. above sea. From Wood mountain to Duck mountain a number of meteorological stations have been in operation for a period thirty to sixty years while since the beginning of the war detailed hourly observations have commenced at a number of airfields in this part of Canada. We have, therefore, a considerable knowledge of the weather variations along this portion of the path of totality.

East of Duck mountain the path crosses the upper portion of the Great Lakes of Manitoba, crossing the west coast of Hudson bay south of Cape Tatnam. In this region we have had meteorological stations at The Pas and Norway House for many years while there were ten years of record at Port Nelson and about forty years of record at the Hudson bay post at York Factory across the bay from Port Nelson. The record from God's Lake, the flying boat landing, has not been eminently satisfactory but from these stations and the long record at Churchill we can make a reasonable approximation to the averages and extremes of July weather.

The meteorological records begin again on the east coast of Hudson bay where we have maintained stations at Fort George, Great Whale River, and Port Harrison. These stations were established between 1915 and 1920 but have not reported quite continuously since that time. We have also some newly-established stations in the interior of northern Quebec which serve to amplify the data for Hudson strait. Observations began on Hudson strait about sixty years ago but have not been continuous during the interval. Finally, we have about six years of records at Pangnirtung in south-

ern Baffinland near the point where the path of totality leaves Canada.

Utilizing the meteorological data available from our archives, we give a brief resumé of the weather possibilities for the month of July. The chief interest in the weather will be focused on the likelihood of clouds obscuring the observers' vision. The worst mischance which can befall will be a rainy day. It appears from the records that from Regina to Hudson strait the number of days with measurable rain

PERCENTAGE-FREQUENCY OF CLOUD-COVER—JULY

Time (Eastern)	0730			1330		
	x	*y*	*z*	*x*	*y*	*z*
Regina	40	19	42	34	21	45
Yorkton	44	24	32	22	36	42
The Pas	34	32	34	17	48	35
Churchill	18	17	65	13	24	63
God's Lake	20	13	67	0	23	77
Pt. Harrison	8	14	78	16	18	66
Hope's Advance	8	29	63	10	39	51
Nottingham Island	8	10	82	15	10	75
Resolution Island	8	13	79	17	9	74

x cloud-cover 0 to 2 tenths
y " " 3 to 7 "
z " " 8 to 10 "

NORMAL AND EXTREMES—JULY

	Temperature			Rainfall		Snowfall	
	A	B	C	D	E	F	G
Regina	79	51	65	2.38	10	Nil	0
Yorkton	78	52	65	2.45	10	"	0
The Pas	75	54	65	2.22	10	"	0
Flin Flon	76	56	66	2.46	9	"	0
Churchill	64	43	54	2.19	10	"	0
Pt. Harrison	55	39	47	1.19	10	"	0
Nottingham Island	49	35	42	1.58	10	0.9	1
Resolution Island	42	33	38	1.94	12	trace	
God's Lake	73	55	64	2.44	10	Nil	0

A—Mean daily maximum temperature.
B—Mean daily minimum temperature.
C—Mean daily temperature.
D—Total rainfall in inches.
E—Number of days with measurable rainfall.
F—Total snowfall. G—Number of days with snowfall.

in July everywhere averages 10. On the north shore of the strait and thence eastward to Resolution Island the number increases to 11 or 12. The chance of a day without rain, therefore, is approximately 2 out of 3. Even if there should be no rain, we may have sufficient cloud completely to obscure the eclipse. From the hourly readings during two Julys at Regina airport we have made a curve showing the total amount of the sky obscured at each hour of the twenty-four. This indicates that the chance of cloud increases on the plains of Saskatchewan from early morning to late afternoon. As the temperature rises the cloud-cover widens and thickens. This is an ordinary meteorological phenomenon on a fine day with slightly unstable air lying over ground which is absorbing heat from the sun. On such a day the clouds begin to dissipate after the hour of maximum temperature. The cloudiness depicted by the curve shows the total cloudiness irrespective of the height of the cloud or its type. Cirrus clouds occurring alone might allow at least an imperfect view of the eclipse.

There are usually, however, opaque clouds at lower levels. The hourly observations at Regina in July show that altocumulus is the most common type and is visible on 25 to 30 per cent. of the 744 hours in the month. The next most common variety of cloud, cumulus, was recorded 22 per cent. of the time in July, 1943, and 32 per cent. in July, 1944. Undoubtedly, the worst types of cloud from the astronomer's point of view are stratus, stratocumulus, and nimbostratus since they usually occur in extensive sheets and present a dark grey appearance. These types were recorded 8 per cent. of the time in July, 1943, and 17 per cent. of the time in July, 1944. The skies totally or almost totally obscured by cloud may be expected to occur on 50 to 100 hours during the month. Unfortunately, most of the cases of total obscurity accompany a frontal passage, which may occur at any hour of the day or night. It is, therefore, not possible to differentiate between the chance of total obscurity at the time of totality and any other hour of the day. Reports from the airport at Yorkton tally rather closely with those from Regina. The chance of total obscurity is, therefore, from about 1 in 8 to 1 in 16.

On days with broken to scattered clouds the sun's place might be clear of cloud at the time of the eclipse and the chance of such

visibility is, of course, increased the smaller the percentage of sky clouded. Since the time of totality in Saskatchewan is near the time of the regular morning synoptic observation, that is, 0530 M.S.T., we have summarized the cloud observations taken at this hour, dividing the cloud-cover into three classes—0 to 2 tenths, 3 to 7 tenths, and 8 to 10 tenths. We find that 40 per cent. of the observations fall into the first class, 19 per cent. into the second, and 42 per cent. into the third. The chances are, therefore, nearly even to even that the sky will be covered by less than 2 tenths of cloud or more than 8 tenths. In the years prior to the recent period of hourly observations at airports the synoptic meteorological obser-

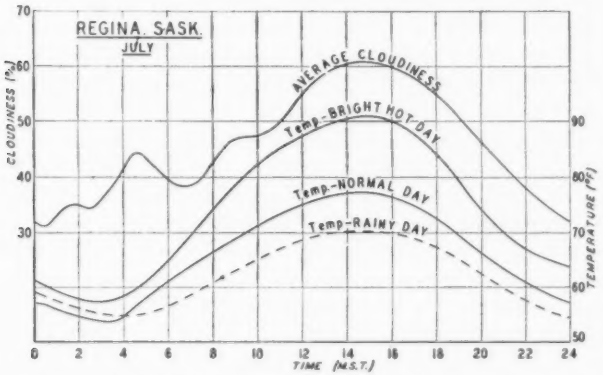


Fig. 1.—July Cloudiness and Temperatures in Regina, Sask.

vations at the fixed hours 0530, 1130, and 1730 M.S.T. show the same distribution of cloud; that is to say, 35 to 40 per cent. of the observations showed 20 per cent. or less of the sky clouded and 45 to 47 per cent. of the observations showed the sky 80 to 100 per cent. clouded at 0530 M.S.T. Only about 15 per cent. of the observations at this hour showed a moderately clouded sky. It appears, therefore, that very good or quite bad conditions for observations are equally probable. We have already mentioned that rainy days occur on about 1 in 3. Days without rain, however, show this tendency to prefer either small or large amounts of cloud. In this connection, the secondary maximum of cloudiness near sunrise

derived from hourly observations of the last two Julys is of some interest. The hourly readings have not continued long enough to let us be certain that this is a fixed characteristic of southeastern Saskatchewan. Its proximity to the hilly region along the Manitoba-Saskatchewan boundary lends some credence to the reality of this secondary maximum at least on mornings which follow a clear or reasonably clear night.

Leaving out of consideration for the moment the weather along the eastern stretch of the path of totality, we might consider some of the regional peculiarities of eastern Saskatchewan as disclosed by hourly observations in July. It seems that if the wind is from the south or southeast during the night and there is no frontal surface near, we may expect two or three tenths of cirrus cloud with a trace to one tenth of altocumulus cloud underneath about the time of totality, while by 0800 M.S.T. there will be increasing cirrus cloud with small amounts of altocumulus and altocumulus castellatus underneath. If the day is very warm, heavy cumulus will begin to appear by noon and if altocumulus castellatus has been seen in the early morning, one or two tenths of cumulonimbus may become visible with distant lightning to the east. Winds from the west-northwest and northwest, particularly when strong, are either accompanied by intermittent precipitation or, if continuing for one or two days after a rainy period, are generally accompanied by considerable low or middle cloud. Under these conditions cloudiness increases noticeably by noon. Moderate to strong westerly winds which have immediately followed a period of strong west-northwest winds may also be expected to be accompanied by clouds such as stratocumulus on the following morning. On the other hand, light to moderate southwesterly or south-southwesterly winds two or three days after rain has occurred are usually forerunners of only traces of cumulus and altocumulus cloud at sunrise although fleecy cumulus clouds of fine weather may increase to 30 to 50 per cent. of the sky by the early afternoon. Moderate to strong northeasterly winds are usually accompanied in July by extensive sheets of cirrus with altocumulus and altostratus forming underneath. Northeasterly winds persisting for more than a day may be expected to bring moderate to heavy low cloud. If, however, a frontal system is approaching eastern Saskatchewan, the day will almost certainly

be very cloudy regardless of the direction of the winds preceding the frontal surface.

When we pass across the Great Lakes of Manitoba towards God's Lake, we find that the observations available from God's Lake for July indicate 80 to 100 per cent. cloud occurring more than 50 per cent. of the time at 0630 C.S.T. with considerably increased chance of cloud towards noon. We also have the experience of the aerial photographic surveys in the Hudson bay region which have frequently met extensive sheets of high cloud along the west coast

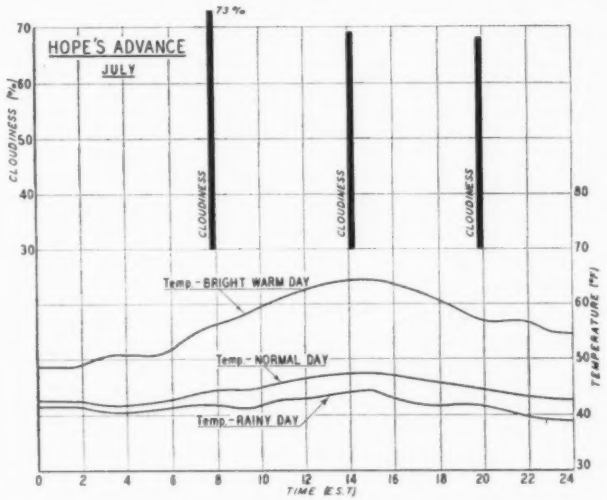


Fig. 2.—July Cloudiness and Temperatures in Hope's Advance.

of Hudson bay on days when fine, warm weather could be forecast for the region. The extreme coolness of the Hudson bay area in July contrasted with the normally warm to hot weather of the prairies should, from meteorological considerations, lead us to expect considerable cloudiness at 10,000 to 15,000 ft. during the time that the temperature is rising to the west. Cloudiness observations from the synoptic observations at Port Nelson and Churchill in past years support the idea that the chance of good weather for observation is smaller along the west coast of Hudson bay than on the prairies.

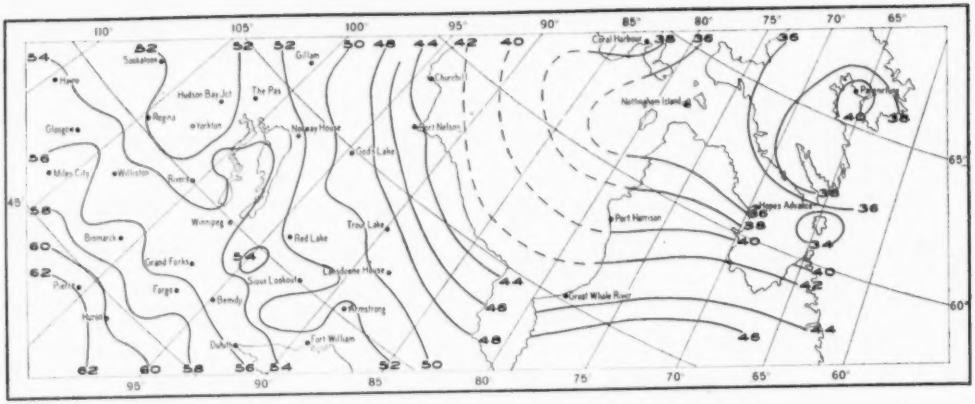


Fig. 3.—Mean Daily Minimum Temperatures—July.

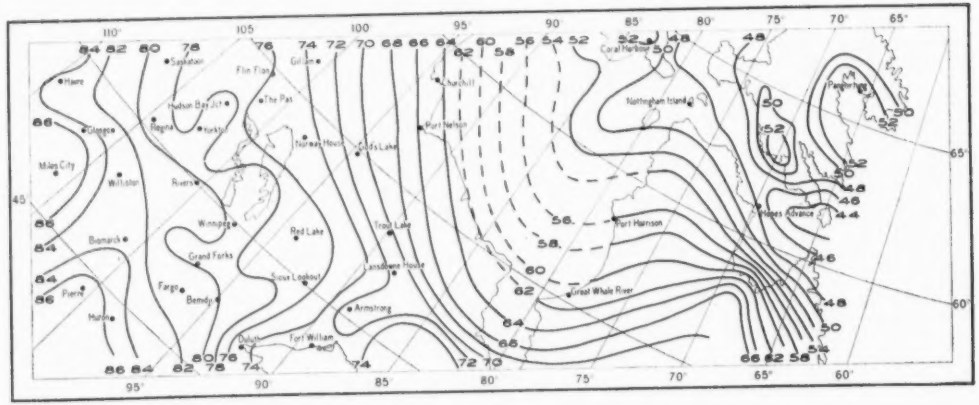


Fig. 4.—Mean Daily Maximum Temperatures—July.

In the Hudson bay area meteorological observations have always been taken at places quite close to the water and it might be argued that the observations are thereby biased in favour of bad weather. This argument might very well apply to fog which may be expected to occur on 7 to 10 forenoons in July at Hope's Advance. The passage of ice from the Foxe basin certainly must contribute towards the expectation of low-lying fog in the strait area. Undoubtedly, on the higher land of the interior south of Cape Wolstenholme and distant from the icy waters fog should not be common although we have no observations to support this supposition. In respect to cloud, however, we do not suppose that the path of totality crossing about 100 miles of the Wolstenholme peninsula should be much more favoured than Port Harrison, Nottingham Island, Hope's Adance, or Lake Harbour, all of which show 70 to 75 per cent. cloudiness in July. At Resolution Island, at the eastern entrance to the strait, there is even more cloudiness. We have no observations for the interior of the Hall peninsula which forms the southeastern portion of Baffinland but the general features of the terrain and the proximity to winds off the Atlantic do not lead us to expect much better conditions than those obtaining at Resolution Island.

On the whole, it appears that the best chance of viewing totality on July 9, 1945 lies in the Saskatchewan area. We believe that reasonable chances of success are about the order of 3 in 5 in Saskatchewan and probably less than 3 in 10 in the Hudson strait area, with the region around God's Lake intermediate.

Since the temperatures to be expected during the day may be of some interest, diagrams are given to show the normal diurnal march of temperature during a July day both in the Saskatchewan area and at Hope's Advance. Accompanying the normal curves are two others—one showing the diurnal march during a rainy day and the other during a warm, fine day. Since the time of the eclipse in Saskatchewan comes near the normal hour of the occurrence of minimum temperature and not long after the minimum in the eastern region, we have included a map of normal daily minimum temperatures from Montana to Baffinland. For the benefit of those carrying on observations during the remainder of the day there is also included a map of the normal daily maximum temperature. It might be noted, however, that extraordinarily warm weather does

Fig. 4.—Mean Daily Maximum Temperatures—July.

occasionally occur in southeastern Saskatchewan in July. The highest temperatures on record in south-western Manitoba and southeastern Saskatchewan occurred in July, 1936, when some meteorological stations reported more than 110°F. In the Hudson strait area temperatures between 70 and 75°F. are occasionally observed at Lake Harbour on the north shore.

Meteorological Service of Canada,
315 Bloor St. West,
Toronto, Ontario.

RUSSIAN ECLIPSE PLANS FOR JULY, 1945*

By G. Fesenkov

DURING the first months of the war Soviet astronomers made their preparations for observation of the eclipse which took place on September 21, 1941. We sent out seven expeditions in the path of the eclipse, mostly in the region of Almaata, and these made use of a number of instruments which Soviet workshops had built especially for the eclipse. Some very interesting results were obtained.

The eclipse which will take place July 9, 1945, will be observed by no less than 22 Soviet expeditions which will use mostly those instruments that were made for the 1941 eclipse.

In addition to the main observations by experienced scientists, a number of young astronomers will be drawn into the work. In order to ensure success of the observations every movement of the observers must be calculated in advance and carefully rehearsed. Every exposure must be correctly made as it is impossible to correct mistakes that have been made. Thanks to the experience gained during the 1941 eclipse we are able to draw up a precise plan of work for the main instruments. Many problems which already have been studied will be studied anew in order to obtain new material.

During the eclipse of 1941, Professor Sharonov determined the temperature at the sun's surface at 4500°C. This figure is of great importance to the theory of the physical nature of the sun and must be checked during the coming eclipse.

Professor Mikhailov discovered during the eclipse of 1936 that the curvature of rays proceeding from distant stars and passing near the surface of the sun is considerably greater than that forecast by Einstein's theory of relativity. This is another point that must be checked up by the same apparatus.

Professor Kalinyak of the Almaata Institute of Astronomy and Physics, using his own interference method, made first calculations of the basic width of the streamers in the sun's corona and obtained

*From a cable received by the R.A.S.C. from Professor Fesenkov, Chairman of the 1945 Eclipse Commission.

a figure which can only be reconciled with the theory if their temperature is extremely high and far in excess of that at the surface of the sun. These observations were only partially successful in 1941 and must be made again in 1945 with a view to obtaining the greatest possible information concerning the sun's corona.

Markov and others using photographic cameras five metres in length placed at various points along the path of the eclipse, measured the speed and direction of the movement of matter in the sun's atmosphere and established a close connection between the intricate structure of the corona and the various active regions. A stratosphere flight will be arranged and observations will be made beyond the cloud layer and under conditions of little atmospheric light.

At a conference in Moscow in October, the 1945 Eclipse Commission discussed the scientific subjects to be studied, examined a number of proposals for improved methods of observation and laid down places to which expeditions will set out toward the end of May, 1945. The places determined on are Serdobel, Svir, Babayevo, Vesyegonsk, Runinsk, Ivanovo, Gorky region, Kuibyshev region and Urals region. The expeditions will probably include 100 specialists, 70 juniors and the necessary technical staffs.

Moscow, U.S.S.R.

IMPORTANT CONSIDERATIONS IN MAKING REFLECTING TELESCOPES

By Frank Vaughn

THERE has been a considerable flow of ink in the past several years concerning the relative merits of refractor and reflector so that discussion along lines already much written about would be largely superfluous. However, it appears that many practical points in the construction of the reflector, if realized at all by the greater number of makers, amateur and professional, seem to be largely ignored; and it is with a view to this failing that I launch into a brief discussion of desirable features a reflector should possess, and of *why* these features are desirable. In this way perhaps some enterprising readers will develop further the ideas presented, thus hastening the day when the reflector will attain its rightful position alongside the refractor in work of delicate visual resolution. Many of the remarks presented herein apply to refractors also.

The reflecting telescope has acquired a somewhat odious name to those amateurs and (few) professionals who have in mind an instrument for the purpose of delicate visual observation, e.g. planetary and double star work.

I believe that much of this condition is caused in the main by a number of failures of conception on the part of the observer and telescope maker. The prime cause seems to be a lack of skill in producing a sufficiently *fine* primary mirror, a difficult task in sizes above 8-inches or so. A powerful consideration is the fact that a reflecting surface is approximately four times as sensitive to errors of figure as a refracting surface of ordinary optical glass. To the rejoinder that the achromat has at least four surfaces by way of compensation, I should reply that they, by virtue of relatively steep curvatures, are physically prevented from straying too far from the spherical shape they demand. An error produced on the relatively flat fourth surface would have to be bad indeed to affect appreciably the performance of the combination. If the mirror-form of instrument required but a spherical primary, the problem

would not be a difficult one; the parabola, however, is a curve requiring care, skill, and a thorough understanding of its form relative to the reference-sphere from which it is commonly produced.

Experienced optical workers hardly need be reminded that, size for size, the mirror is a far more recalcitrant child than the comparatively obedient lens and that a correspondingly larger amount of care and "understanding" must be lavished on the common plate glass or pyrex disk. As a rule it is impossible for the professional maker to spend a sufficient amount of time on a mirror without losing money. With the advent of the "amateur telescope maker" competition in this field has become *too* keen for the good of the reflectors, as low prices can have but one effect on the quality of them, advertisements to the contrary.

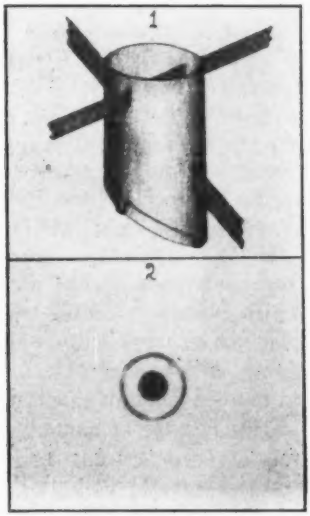
Another common failure, at least in small reflectors, is the poor choice and design of the secondary or 45-degree mirror, which deflects the rays from the primary. A popular notion is rampant that a piece of commercially polished plate glass of a fair degree of flatness is adequate, and the *few* makers (amateur and professional) who do produce a really fine primary, frequently bow to common practice by using these scraps of glass in an otherwise excellent system. It may be well to mention in passing that a large-selling and popular book for the telescope maker condones this usage, apparently from igorance of the performance that a really high-class reflecting system *is capable of*.

There are two good reasons why the felt-polished plate glass diagonal should be relegated to the waste can (better still to windows) the main of which is the poor (lemon-peel) finish of its surface. An observer familiar with the appearance of a *good* star disk can readily perceive the scattered light attendant upon this unfortunate practice. The secondary reason (nevertheless an important one) seems to be that few makers actually test these diagonals for flatness. Even if this is done, and the planeness found good, the above should bar their use without question from any well-planned telescope.

In summation of the considerations for the proper type of diagonal mirror, I should like to urge the use of an accurately figured ($\frac{1}{2}$ wave at least for primaries of 8-inches and below, and better for larger sizes) and *optically*-polished plane of an elliptical

shape, with the major axis equal to the $\sqrt{2}$ times the minor axis, and of sufficient thickness to withstand any slight strain which a firm-holding cell might impose on it. The Cassegrain secondary needs only passing mention in the form of an appeal for greater carefulness in its making, of which there has been an obvious lack in the past.

A further consideration in dealing with the aforementioned ill fame of the reflector is the very poor design usually adopted for



the system. While refractors have for many years been, for the most part, standardized at about f·15, it would seem that each maker of the reflector puts every whim and fancy at his command into his production, frequently expecting f·15 performance from an f·4 to f·8 primary of doubtful quality, and, failing to obtain what should be obviously impossible under the circumstances, takes the side of the smaller refractor, which naturally gives better performance from its intrinsic qualities of easier figuring and longer focal ratio. It is within my knowledge that a man purchased a

12-inch Cassegrain from a well-known maker, later discarding it in favour of a 5-inch refractor! The inference is here obvious.

Another practice to be strongly censured is the employment of unnecessarily heavy diagonal supports, in effect trying to *overcome* with brute force what can be *accomplished* with great nicety with a little thought. Thick supports add greatly to diffraction effects, while adding little or nothing to the stability of the secondary. By using two *thin* strips of metal at 90° to each other, and displaced by some distance along the optical axis where they cross through the tube holding the secondary, a strong support is had with a minimum of undesirable diffraction effects (see fig. 1). Three supports spaced 120° apart should never be used as they are not only much less stable, but produce six diffraction lines through a bright star image.

The question of the proper design of the supports for the primary mirror is a difficult one, hence any rules laid down must be largely arbitrary, owing to the number of uncertain factors involved. Small mirrors of not above say eight inches in aperture and at least $\frac{1}{8}$ diameter in thickness probably require no more than the simple measure of three felt pads at 120° intervals and situated seven-tenths of the distance from centre to periphery. I have found particularly effective a ring of felt of small width and thickness, though this type of mirror support can only be used if the bottom of the cell is quite regular in shape, that is, not warped. One "case history" might here be of value. A 7-inch mirror one inch in thickness and of very accurate figure, and with a 45° secondary accurate to 1/5 wave of violet light, belonging to me, was mounted in a turned wooden cell and supported at the back by three thin circular felt pads in the positions before described as proper. While the performance was very fine,* even to other experienced observers, I noticed that with a magnification of 300

*This optical system (at 300X) revealed Encke's division almost immediately to Charles Gramm, who was not before aware it existed, and who asked, shortly after looking into the eyepiece, what the division in the *outer* ring of Saturn was. He *had* heard of Cassini's division, and his observation was soon checked by Hugh Johnson, Robert Smith, and myself. Rather ludicrous are the popular "tests" amateurs judge the quality of their telescopes by, e.g., separating the components of ϵ_1 and ϵ_2 Lyrae, and being able to see Cassini's division in Saturn's rings.

on a 4th magnitude star, although the diffraction, or Airy, disk was very perfect, the first diffraction ring surrounding the spurious disk was "faded out" at three points corresponding to the positions of the felt pad mirror supports (see fig. 2). The ring was otherwise quite beyond reproach, and this barely visible phenomenon had no apparent effect on the Airy disk. From this one might judge that on mirrors of much larger diameter, say ten inches and up, a regular support system might justify itself, but the problem is so tangled up with diameter-to-thickness ratios, relative strengths of different glasses, and volume to surface proportions, that in the end it is probably best to give the mirror a large margin of safety, that is, if in doubt, it would be best to install a regular system of supports. I have seen a 9-point support system perform successfully on a 24-inch mirror, the criterion being the lack of any apparent astigmatic effects in an otherwise poorly corrected primary or secondary. It is somewhat ironic that the instrument is by a highly regarded maker, and is beautiful enough in appearance to excite the admiration of the public, although the whole thing is quite useless for any delicate work.

This paper will be terminated by a short discussion of the proper tube-design of the reflector, and, though last, it is by no means the least important factor in utilizing the instrument to its fullest capabilities. Uninsulated metal, metal framework, or any type of open tube has draw-backs obvious to discriminating observers who have had experience with them. The gravest criticism of the open tube is that the body heat has free access to the path travelled by the light rays, this consideration becoming increasingly serious the greater the disparity between the air and body temperature. Metal tubes have diverse faults apparent at once so that one may say with some certainty that their widespread use is due largely to esthetic considerations, a poor standard in these matters.

The most satisfactory materials seem to be those having good insulation qualities, implying a low heat-conductivity factor. Wood is a good example of an almost ideal material, being easily procurable and yielding readily to simple tools. With a little care in construction the esthetic inclinations of the maker may also be demonstrated, though I personally prefer the kind of beauty to be found in a fine stellar or planetary image. It seems desirable

to have the tube (whether square, hexagonal, or some other shape) at least three inches larger in inside diameter than the primary mirror as the most troublesome currents seem to "hug" the sides of the enclosure. I have also verified in the past that a small fan directed from the bottom of the tube has a good effect in dispelling currents which stray over the mirror.

In conclusion I wish to make an urgent appeal to all who undertake the construction of a reflector to give due weight to each portion of the instrument, remembering that each part is dependent, in greater or less measure, on every other. I make this appeal the ***more urgently*** as the reflector seems to have degenerated into a nondescript handyman's plaything of an idle hour. Given half a chance this form of telescope need offer apologies to no present form of astronomical instrument.

Medical Platoon, Station Hospital,
Cp. Bowie, Texas, December 21, 1944.

PERIODICITY IN POPULATION FLUCTUATIONS*

D. J. McDonald

The Bible records mouse plagues; Aristotle remarked on the rise and fall of a mouse population; through the ages, reference to the cycle of irruption and decrease of small rodents abound in the literature; the migrations of lemmings in Scandinavia have become legend. But it is only since the turn of the century that notice has been drawn to the regularity of this cycle, its almost cosmic import. In focusing attention on this regularity, zoologist Charles Elton of Oxford has had a chief place, and in the work being reviewed, he covers the history of occurrences of mouse outbreaks throughout the world, the relationship of these outbreaks with other biological populations, including man; particularly, he indicates the present approaches to the study of wild animal populations and the possible causes for fluctuations. All this is done with charm, admirable reserve, above all with a fine humour, a trait noticeably and sadly lacking in most scientific treatises.

Countrymen have long been sensible of the tremendous havoc wrought by mice on plant life, particularly to agricultural crops and forest plantings. Recent work shows relationships with diseases of men and animals: water voles, mice and lemmings are liable to tularaemia; voles and mice act as a reservoir for bubonic plague, for Japanese river valley fever, a mite-transferred disease akin to typhus, for Rift valley fever of man and sheep in East Africa; in Central Europe, food poisoning ("ptomaine poisoning") may be caused in man through mice. Realization of this economic importance has led to resource to authority for relief; in olden days, offerings were made to Apollo; now a government commissioner is called in. In France in particular, this latter approach has led to attempted control with poisons, with cultures of bacteria to cause disease; the cures, with patience, always work, for the cycle of abundance and scarcity has a rhythmn of its own which inevitably results in a crash. To date, there has been no experiment with adequate controls to show

*Voles, Mice and Lemmings: Problems in population dynamics. Charles Elton: Oxford, 1942.

how much effect these methods have in producing a crash and no way has been devised of preventing a fresh outbreak. Only now do we have the tools with which to predict when this may occur.

In the North, mice and lemmings themselves become a crop, harvested by trappers in the form of furs of fox, white and colored, and of marten. Half the book is devoted to a skilled sifting of the fur returns of the Hudson's Bay Company, the Moravian Missions, and the Revillon Freres for Labrador and Ungava in order to demonstrate a periodicity in the numbers of furs taken, and, therefore, in the densities of fox populations. This is correlated with remarks in traders' journals, in travellers' reports, in the diaries of missionaries on the abundance of voles and lemmings; and it becomes evident that the two are connected and that, in so far as we can say one thing is the immediate cause or predecessor of another, a peak in small rodent populations results in a peak of pelts taken. Correspondently, with the peak of mouse and fox, there occurs a peak in marten, in predatory birds (owls, hawks, shrikes), to a lesser extent in game birds (the idea that predatory pressure is temporarily decreased on these game birds owing to the abundance of more readily obtainable food is not generally accepted; rather, there seems to be some very profound influence making the environment alternately favorable and unfavorable to life). There is a tremendous chain of interrelated factors here; in the end, if we wish a human standard, whole populations, small it is true, of trapping peoples, Indian and Eskimo in Canada, Yukaghir and Tungus in Siberia, have come to depend upon this crop as their mainstay, and the cycle profoundly affects their lives.

Thus, it is established with some assurance that there is a cycle of wildlife in Labrador and Ungava, that it has some regularity, a periodicity of ebb and flow, a periodicity varying around four years, regional and often coinciding over a great area. Elsewhere we see a similar periodicity: three to four years in lemming migrations, which indicate increases in population above that which the mountains of Scandinavia can support; four years in the United States; in France and Germany, five years; in eastern and northern Siberia, four to five years; ten in south-western Russia. These outbreaks do not cover whole countries; often they are confined to a few countries or a particular area; but somewhere in each of these major divisions a

peak occurs at an interval about these means. There is, then, a parallel, possibly a broadly synchronous phenomenon on both sides of the Atlantic. How to explain this? Some climatic cycle? But recent work shows that the synchronization is not exact; further work may prove that what agreement there is is due to something more than chance. For in Ungava, Lapland, Novaya Zemlya, Arctic Siberia, Kamchatka, Alaska, the Western Arctic and the Arctic Archipelago of Canada, in North and East Greenland, a similar violent fluctuation, based on lemmings, consisting of lemming, arctic fox, and snowy owl, occurs. It is *the* short cycle of land populations in the Polar regions; and the vole cycles of northern Labrador, of Great Britain and Europe are southern extensions of this generous rhythm of the north. There is more than a chance here.

With the short cycle for mouse, vole and lemming populations demonstrated, we can proceed to our main concern, the periodicity of the cycle. We have seen, then, that there is an interval of four to five years between peak years. Elsewhere in the animal kingdom a similar rhythm occurs, though of a different duration. Hewitt and Seton have shown a 10-year cycle for rabbits and their dependent predators in Canada west of Hudson's Bay. Insects, such as grasshoppers, spruce and larch sawflies, show tremendous fluctuations. Fish are subject to similar increases and decreases.

With this fairly established, we must seek causes for the fluctuations and their periodicity. In considering the density of any population, three factors, all variable within limits characteristic of the species, are to be considered. These are movements, reproduction and mortality. Here it is that Soviet work and the work of the Bureau of Animal Populations at Oxford comes to the fore in presenting well designed experiments to measure these factors, to present a mathematical picture of the interplay between increase, dependent upon breeding or immigration, and decrease, consequent on death and emigration.

Attention is first directed to reasons for the sudden depletion of the masses of rodents that have built up, bred, eaten their way to a peak, only to vanish from desolated fields as if they had sunk back into the earth. Three groups of theories have arisen, based respectively on predators, epidemics and climate as causes.

First, predators. Kalabukhov (Russia) holds that as populations of small rodents increase, food supplies on occupied area tend to diminish, resulting in lesser cover and more exposure to predators. The predators increase due to an abundance of prey, and pressure is increased to such a point that a marked reduction in prey numbers occurs; a crash has taken place. This is somewhat akin to the American idea of "carrying capacity of cover." But in Britain, where predators are few in number, crashes occur regularly. Voles may strongly control the local abundance of predators, but the latter do not control the numbers of their prey or cause fluctuations.

Whatever the original causes may be, fluctuations are often accompanied by periodic crises of epidemic mortality, often when the population has reached a high density. This has been demonstrated; tularaemia in Norwegian lemmings, murine typhus (used for biological control in France), mouse tuberculosis, discovered in 1937, a protozoan parasite of the brain which accompanied several British crashes. This seems the most natural theory to account for decline after a peak: overcrowding leads to an increase in contacts between voles, an increase in the disease-carrying parasites (fleas, mites, etc.); any disease could spread like fire through the population.

But, though disease may be proved as a cause in one instance, that does not prove that it always controls the rhythm of the cycle. For disease may flare up at any density of populations, and many crashes have occurred without disease accompanying them. Unless there is some organism that has escaped investigators, we must look elsewhere for the causes for regular occurrences of vole-crash periods.

Climate must be considered. Sviridenko, a Russian worker, has shown that, though rodents have temperature regulations in their bodies, they are easily upset by abnormal heat and cold. Similarly, damp or wet fur causes death from cold. He concludes that the sudden disappearance of rodents after abundance is due to abnormal weather. In Germany, the official view is that dry weather is associated with unusual increase in voles. In southern Scotland, the great outbreaks of 1875-6 and 1891-2 have been correlated with areas of maximum rainfall. Goldie (Scotland) correlates vole peaks with a recurrent change in pressure-gradients (and therefore in wind direction and strength), and with sunshine, temperature and rainfall.

British workers have recently shown that the breeding rhythm of voles is correlated with length of sunshine more closely than with any other climatic factor, temperature included. We may note here the work of Rowan in Alberta on migration of birds and amount of light hours per day. Baashuus-Jessen, a Swedish worker, without much direct evidence, proposes that climatic changes are capable, through alterations of vegetation or directly by lowering the immunity of the body, of causing high mortality in small animals and birds, a mortality which may be expressed in the symptoms of food deficiency or by successful invasion of tissues by micro-organisms. But, in sum, all this work points in no one direction, and much more must be done before anything can be said concerning the effect of climate on fluctuations and periodicity of animal populations.

Abundance and scarcity of food cannot be proposed as a dominant factor. An attempt at one time was made to connect the ten-year cycle of snowshoe rabbits of Northwest Canada with periods of maximum sun-spot activity. But the sun-spot cycle is an eleven-year one, and the two, in time, go right out of phase.

Fluctuations are general among animal populations. We haven't explained it yet on any one basis. There is here the same rhythmical quality as sound-waves, tides, planetary orbits show. Supposing environmental features (such as climate and ocean) remained absolutely constant? Lotka and Volterra, mathematicians, in 1925, arrived at somewhat similar ideas. Where ecologists believed that external disturbances such as climate, were the primary generating force in causing populations to oscillate with other factors such as epidemics and predator-population changes as secondary results, these theorists believe they could prove by rigid mathematical arguments that groups of ecologically-linked species must fluctuate so that climate and other external influences would merely tend to interfere with the natural rhythm, producing very complex consequences. There is little doubt that their conclusions are broadly true.

But climatic and oceanic conditions do show all sorts of fluctuations, some rhythmical, some much more regular; fluctuations on all scales, from the changes brought about by a cloud passing over the sun, through daily and tidal and annual rhythms, up to the mighty rhythms such as those of the ice age. We know that many of the

chief fluctuations in the basic communities supporting fisheries are caused by recurrent change in certain qualities of ocean water; and climate plays a dominant part in the origin of insect outbreaks such as plagues of grasshoppers. It seems reasonable to attribute to climate an important part in causing the fluctuations in mammal numbers.

The recent British work on breeding seasons, life-expectancies, etc., leads the author to believe that there are inherent properties of the population dynamics of voles that may eventually explain the cycle as a self-contained system that is not so dependent on other animals like predators and parasites as first supposed. Thus the simple disease and climatic theories are gotten away from; even the Lotka-Volterra theories must be reconsidered, possibly applied to the interrelations of physiological properties of a species rather than to a group of ecologically related species.

The only conclusion we can safely arrive at is that most of these fluctuations are an integral property of the living cosmos, that no complete explanation for this mighty pulsation is yet at hand. The book is designed to put as much emphasis on the methods of approach to the subject as on the facts already learned; there is necessary now years of close field and laboratory study, exchange of data throughout the world, which may lead to an understanding of these extraordinary fluctuations, an understanding, the author cannot help believing, based possibly on very curious meteorological and perhaps astronomical processes, and resulting in the discovery of new relations between climate, physiology and disease.

Goose Bay, Labrador.

NOTE: The above is more a summary, necessarily inadequate, than a review, for it is in a large part a paraphrasing of selected sentences and paragraphs of the book. In the absence of a reference library in biology, the reviewer has had to restrain himself from much comment or addition for fear of inaccuracy: there is value in this, for the book is so beautifully done that it should stand as it is, a milestone in animal ecology. Some day, it may be said for "Voles, Mice and Lemmings", as Bertrand Russell says in his introduction to the second edition of "Principles of Mathematics": "Such interest as the book now possesses is historical, and consists in the fact that it represents a certain stage in the development of its subject." For, by the year 1942, work on animal populations had become a fascinating and productive field of human endeavor; its history is here superbly written for all to read.

THE WRAY TELESCOPE OF THE VICTORIA CENTRE OF THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

By K. O. Wright

On October 1, 1944, the Victoria Centre of the Royal Astronomical Society of Canada acquired the 4-inch Wray refractor which has been in the possession of H. Boyd Brydon since 1931. Previous to that time it was owned by A. F. Miller of Toronto who was one of the

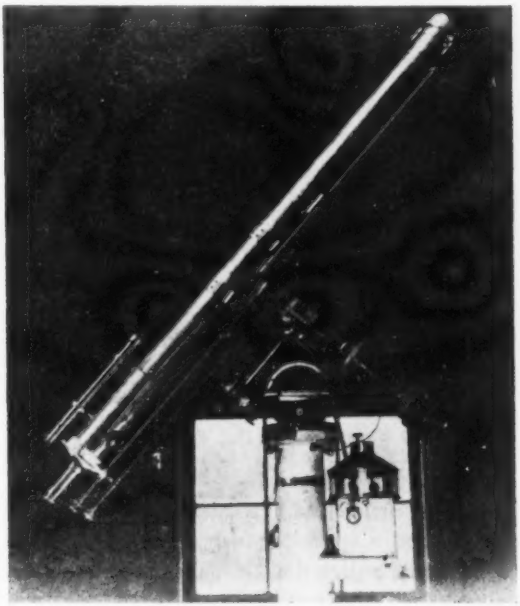


Fig. 1.—The Wray Telescope of the Victoria Centre.

charter members of our astronomical society. For the present the telescope remains housed in Mr. Brydon's Oak Bay Observatory, which is shown in the Plate, but the Council of the Centre hopes to

find a permanent location for it, where it will be available not only to the Society but to all members of the community.

The telescope is equatorially mounted, clock-driven and is supported on a 5 ft. 6 in. cast iron pillar based in concrete. The 4-inch objective was made by Wray, the famous London lens maker, and gives beautiful definition. The substantial equatorial mounting was made by Stewart of London, of brass and gun metal. The driving clock is weight driven and the speed is controlled by an adjustable centrifugal governor. The hour and declination circles are graduated

Fig. 2.—Mr. Brydon's Oak Bay Observatory.

on silver and are provided with verniers to read to five seconds of time and one minute of arc respectively. The hour circle is of Airy's design which permits setting the telescope on the desired object without calculation: the movable circle is set to read the right ascension of the star and clamped; the telescope is then swung about the axis until the fixed mark on the meridian reads the sidereal time on the same circle. Both circles are fitted with microscopes and illuminated by low-voltage electric lights. The finder has a 1 1/8-inch objective and is also provided with electric illumination of the cross-hairs.

When it was set up in Victoria, the mounting was completely

overhauled by S. S. Girling, now the instrument maker at the Dominion Astrophysical Observatory. At that time a ball thrust-bearing was fitted to the polar axis and clamps and slow motion mechanisms were provided for control of the telescope from the eyepiece.

Included among the accessories are: seven achromatic eyepieces giving magnifications from 30X to 300X; a Hilger 5-prism McClean spectroscope for use with a telescope eyepiece; a Sims filar micrometer with two eyepieces, position circle and graduated micrometer for double star observation; and a solar observing screen.

The fund to purchase the telescope was raised by popular subscription from members of the local centre. As an indication of the interest in the project, it may be noted that contributions were received from about fifty members.

In order to utilize the telescope fully, an observing section has been formed under the direction of W. R. Hobday, Chairman, Robert Peters, Gordon Shaw and the writer. A regular observing schedule was put into operation early in December and more than twenty members of the society have shown a desire to study variables, double stars, occultations of the moon and other interesting objects in the heavens. It is hoped that this group will soon be making a worthwhile contribution in the field of amateur astronomy.

In the preparation of this note, the writer was aided by H. Boyd Brydon who supplied details concerning the telescope and its mounting; and by W. H. Stilwell who obtained the photographs of the observatory and the telescope.

Dominion Astrophysical Observatory,
Victoria, B. C.
December, 1944.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

A New Set of Sky Maps

The Quebec Centre has recently printed two large sheets of star maps, drawn by Raymond Fortin, a member of that centre. The "Planisphère Céleste" consists of two polar projection maps covering the whole sky. Below these, on the same sheet, is an equatorial projection map covering the region of the sky from declination +50° to —50°. These maps are on a scale of ten degrees to the inch and show white stars on a black background. Stars down to the sixth magnitude are shown and the positions of nebulae and clusters are indicated. Other information is also given: the signs of the zodiac, the Greek alphabet as well as details of four particularly interesting regions of the northern sky, the Hyades, Pleiades, Cygnus and Lyra, and Perseus. Some twenty double stars are shown as they would appear in a three-inch to six-inch telescope. This sheet, about three and a half feet square, is suitable for mounting as a wall map.

The "Voûte Étoile" consists of four horizon maps, one for each season. These have a diameter of about eleven inches and are drawn for latitude 45° north. The stars are again white on a black background. On the maps is additional information concerning the phases of the moon, the solar system and details of the Cygnus-Aquila region and the Orion-Taurus-Auriga region.

The Quebec Centre is to be congratulated in producing these excellent maps by M. Fortin.

Another interesting item from the Quebec Centre is that the Maryland Academy of Sciences has produced a French edition of its Graphic Time Table of the Sky for 1945. This is being distributed by the Quebec Centre of the Royal Astronomical Society of Canada.

R.J.N.

Astronomy Always Useful

A trip to Florida in the winter is a pleasing experience in itself, and it also affords the opportunity of visiting valued friends in Washington. At the David Dunlap Observatory, after a very fine autumn, the winter set in with a fierce blizzard on December 12, and

storm after storm followed, blocking the roads and causing great inconvenience. The present writer left Toronto on January 17 and the abundance of snow appeared to persist until near Washington. Indeed in the capital, during the night preceding the President's historic fourth inauguration, two inches or more of snow fell. The visitor felt special interest in being in the city at this time, for, while one could almost as well listen beside one's radio a thousand miles away there was a peculiar feeling of reality in hearing a graphic description of the scene at the White House and then the voices of those taking part in the solemn ceremony as it was performed a few city blocks away.

At the U.S. Naval Observatory a guard still sharply scrutinizes everyone who wishes to enter its gate, but a word from a companion allowed the writer to pass.

During the past year the rank of the present Superintendent of the Observatory has been raised from Captain to Commodore. Indeed Commodore Hellweg is to be congratulated on being head of the Observatory longer than any one before him except Commander Matthew Fontaine Maury. Commodore Hellweg has had many interesting incidents in his career and one story may be given here. It illustrates how useful simple astronomical observations may be.

The different divisions of Australia were united into the Commonwealth in 1901, and the occasion called forth an international celebration. At that time Commodore Hellweg was a midshipman on the American flagship at Sydney, N.S.W., en route to Melbourne to take part in the proceedings. He and some others had been at an evening meeting connected with the festivities and wished to get back to the dock. They asked a cab driver if he would take them there. The latter warned them that it was a long distance and the cost would be considerable. They asked how much and accepted his terms. The men were very hilarious and sang noisily as the journey proceeded. The midshipman not being a singer could not join in the music, but being an astronomer he naturally made observations. Looking through one of the windows of the carriage he saw a bright object up in the sky, probably one of the planets. A little later he looked again, but found the object in a different direction; it was seen through

a different window. This aroused his interest. Somewhat later it was observed through still another window, and then in the course of time it was seen through the first window. He suspected that the driver was simply running round blocks of the city. Continuing, he observed the same sequence again. With difficulty he quieted the others and told them that they were simply being driven round the city. They would not believe it and began their songs again, but he insisted and at last they stopped the carriage and tackled the driver. He acknowledged his trickery and without more delay drove to the dock a couple of blocks away and they paid him only a shilling apiece for the ride.

C.A.C.

MEETINGS OF THE SOCIETY

AT VICTORIA

October 11, 1944.—In the absence of Mr. Prentice, Dr. Wright called the meeting to order at 8.15 p.m. The minutes of the previous meeting were read and adopted. The Secretary of the Summer Course in Astronomy presented a report, indicating that an average of 45 attended the lectures and 60 the outdoor observation meetings. As a result of this summer course seven new members have been admitted to the Centre, and their names were read. Mr. Peters gave a brief review of the objects of particular astronomical interest to be viewed at this time. It was reported to the meeting that there was still some $25 required to complete payment of the cost of the Brydon telescope, and a description of the instrument, prepared by Mr. Brydon, was read to the meeting by Dr. Wright. It was announced that at the next meeting of the Centre we would be permitted to visit the planetarium at Royal Roads, and all members wishing to avail themselves of this opportunity were asked to give their names to the Secretary following the meeting. It was pointed out that anyone interested in contributing to the Prof. Elliott Scholarship Fund for Victoria College could secure the necessary forms at the desk.

Professor Wallace then delivered the address of the evening on "Fingerprints—The Development of Numbers." It is believed that all men possessed even in the earliest stage a "number sense" which enabled them to perceive, without actually counting, whether an object or objects had been added to or taken away from small collections, but this number sense does not appear to extend beyond four. A similar number sense, limited to two or three, appears

to be possessed by some birds and insects. This number sense has nothing to do with counting, counting being a strictly human development involving mental processes. From this basic number sense man proceeded to the process of matching, making use of the one-to-one correspondence of objects in two collections, still without involving the process of counting. Names were then given to collections having matching parts (for example, wings of a bird means 2 in some tribes). Following this, a set of models was no doubt suggested to represent the collections, and a new measuring stick, the integers, was introduced. In most primitive languages the word for 5 is hand, 10 is two hands, and there is no doubt that the articulate five fingers have taught man to count and extend the scope of numbers; without them he might not have gone far beyond elementary number sense. The principle of position came only with the written or recorded numbers, in the fifth century A.D., and this position characteristic was necessary before arithmetic could be created. Professor Wallace discussed the binary and quinary systems (two- and five-number systems) of various primitive tribes, their multiplication and addition tables, and gave several interesting examples of number systems in use today.

Mr. Peters spoke briefly, thanking Professor Wallace for his very interesting address which it was evident had been much appreciated by the members present.

November 8, 1944.—The Victoria Centre of the R.A.S.C. held its regular monthly meeting on Wednesday evening, November 8, 1944, at the newly constructed planetarium of Royal Roads Naval College, through the courtesy of Captain J. M. Grant. Lieut.-Commander Genge explained the principal instruments, namely a working model of the sun-earth-moon system and the planetarium machine which shows the configuration of the stars for any time, any night of the year and any latitude. Mr. Robert Peters, and the acting President, Dr. K. O. Wright, pointed out the various constellations in both northern and southern hemispheres, and Commander Tingley and Lt.-Commander Genge explained the action of the tides by means of the model. Mr. W. R. Hobday in his vote of thanks expressed the appreciation of the members for the opportunity of visiting this artificial sky which should prove so useful in learning about the stars.

J. McDONALD, *for Recorder.*

December 13, 1944.—The December meeting took the form of the Annual Dinner held at 6.30 p.m. with about 70 members and friends present. After a toast to the King proposed by the President, Mr. O. M. Prentice, silent tribute was paid to two members who had died during the year, Lieut. C. C. Kernahan and Mrs. A. A. Carter, and also mention was made of the loss to the world of Sir Arthur Eddington. The Secretary-Treasurer's annual report was read by Mrs. M. V. Yarwood, Librarian's by Lieut.-Cmdr. Tingley in the absence of the librarian, the report of the telescope-making section by Mr. Hobday and the President's report by Mr. Prentice. The annual election of officers was con-

ducted and the results reported by scrutineer Mr. P. H. Hughes. The following officers were returned for 1945: Lieut.-Cmdr. R. M. Petrie, Honorary President; Dr. K. O. Wright, President; Lieut.-Cmdr. Andrew McKellar, First Vice-president; W. R. Hobday, Second Vice-president; Miss Jean McDonald, secretary-treasurer; Mrs. W. H. Stilwell, Recorder; Miss Y. Langworthy, Librarian, with a council of six, as follows: Lieut.-Cmdr. C. A. McDonald, Mrs. J. R. Noble, Lieut.-Cmdr. A. Scaith, W. H. Stilwell, C. H. Summers, and Dr. W. P. Walker.

An enjoyable musical program was contributed by Mrs. C. S. Beals, Mrs. Gladys Gillie and Miss Constance Hobday. Mr. Shaw presented a delightful satire on astrology. Dr. John Stevenson gave a vote of thanks to the press and Lieut.-Cmdr. Scaithe thanked the musicians. A special message was sent to Dr. R. M. Petrie and Dr. Andrew McKellar who are now attached to the Canadian Naval Service. A cordial vote of thanks was extended to Mrs. M. V. Yarwood, retiring from the post of secretary-treasurer after valued service.

Mr. Prentiss introduced the guest speaker, Dr. J. A. Pearce, of the Dominion Astrophysical Observatory, who gave a brilliant address on the Pleiades. Dr. Pearce described the mythological and astronomic stories behind one of the largest and most thickly dotted constellations. He told of original researches being carried out at the Dominion Astrophysical Observatory on radial velocity and proper motions of the stars of the Pleiades whose average luminosity is 206 times that of the sun and average size is three times its size, whose distance is 250 light years away and which shows a nebulosity due to dust. The first person to observe some of the stars of the Pleiades was Hipparchus in 130 B.C., who listed them with uncanny accuracy in a stellar chart.

Mr. R. Peters expressed the appreciation of the audience to Dr. Pearce for his very interesting address.

R. C. STILWELL, *Recorder.*

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1890-1945

The Society was incorporated in 1890 under the name of The Astronomical and Physical Society of Toronto, and assumed its present name in 1903.

For many years the Toronto organization existed alone, but now the Society is national in extent, having active Centres in Montreal and Quebec, P.Q.; Ottawa, Toronto, Hamilton, London and Windsor, Ontario; Winnipeg, Man.; Edmonton, Alta.; Vancouver and Victoria, B.C. As well as about 950 members of these Canadian Centres, there are over 200 members not attached to any Centre, mostly resident in other nations, while some 300 additional institutions or persons are on the regular mailing list for our publications.

The Society publishes a monthly "Journal" containing about 500 pages and a yearly "Observer's Handbook" of 80 pages. Single copies of the "Journal" or "Handbook" are 25 cents, postpaid. In quantities of 10 or more copies, the price is 20 cents a copy.

Membership is open to anyone interested in astronomy. Annual dues, $2.00; life membership, $25.00. Publications are sent free to all members or may be subscribed for separately. Applications for membership or publications may be made to the General Secretary, 198 College St., Toronto.

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